**DAQ2111-005RTX Agronomic practices to maximise peanut kernel quality and yield**

**Final Report**

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## Background

Peanuts represent a valuable crop of some 35,000t grown annually in Australia with a total crop value of $40M. The crop also offers essential nutritional benefits for both farming soils in coastal and inland farming systems. Nevertheless, approximately 60% of Australia's peanut demand relies on imports, highlighting the urgent need to boost local production. This limitation also has implications for farm employment in the regions. Enhancing domestic peanut cultivation is imperative for fostering sustainable farming practices. Extensive research conducted by the Sugar Yield Decline Joint Venture underscores the advantages of incorporating peanut rotations to enhance soil chemical, physical, and biological properties in sugar-based farming systems of the Coastal Burnett.

Increased peanut production hinges on achieving consistently high yields. To bolster peanut yields, farmers must embrace disease-resistant, high-yielding varieties and fine-tune their agronomic methods if they lead to better returns on their investment. A profound understanding of peanut varieties and their optimal sowing rates in achieving peak productivity and maximising the percentage of edible-grade kernels, especially in resource-intensive and irrigated conditions. This is particularly critical because peanuts are an indeterminate crop, with grower compensation contingent upon kernel grade, spanning from lower-value oil-grade kernels to high-value Jumbo-grade kernels in runner-type and Virginia varieties.

In response to these peanut production challenges, the Grains Research and Development Corporation has supported the 'Agronomic practices to maximise peanut kernel quality and yield (DAQ2111-005RTX)' project. The project featured peanut agronomy experiments conducted in Bundaberg and Kingaroy during the 2021/22, 2022/23 and 2023/24 seasons. This report offers a brief summary of the findings derived from these endeavours, focusing on Nut-in-shell yield and kernel quality - the proportion of edible grade kernels.

## Methodology

Six field trials were conducted in two environments (Kingaroy and Bundaberg) over three seasons (2021/22, 2022/23 and 2023/24) to study the impact of variety selection and sowing rate on productivity and kernel quality. The experimental site at Kingaroy was at the Kingaroy Research Facility (26.57° S, 151.82° E). The soil type at this facility is a typical Red Ferrosol (Australian Soil Classification), for each of the three seasons a different block at the facility was selected. The Bundaberg experimental sites were located at Farnsfield (25.089$^{o}$ S, 152.266$^{o}$ E) on a Red Dermosol soil type (ASC) in 2021/22; at Alloway on a Red Kandosol

(ASC), 24.948° S, 152.389° E, in 2022/23 and at Farnsfield on a Yellow Dermosol (ASC) 25.093° S, 152.276° E in 2023/24.

The trial design was a split-plot design. The main plots consisted of five varieties (Alloway, Holt, Kairi, P85, and Wheeler for the 2021/22 and 2022/23 seasons; in the 2023/24 season, Wheeler was replaced with Fisher due to seed availability issues. The sub-plots had varied sowing rates to achieve populations of 60,000,120,000, 180,000 and 240,000 plants/ha. The seeding rate was chosen based on the seed viability (germination percentage) of the individual variety supplied by the seed company, Bega Peanuts. Amongst the varieties, Alloway, Holt, Kairi, and P85 were a runner-type while Wheeler/Fisher were a Virginia-type. The treatments were replicated three times.

The treatments were randomly allocated in experimental units of three 1.83m wide beds by 20m long (109.8 $m^2$). Two rows of peanuts were established on top of the bed in rows 85cm apart.

The variety and plant population treatments were common across sites, which were implemented using the same sowing equipment. Seed metering was done via a vacuum plate planter with the sowing rate electronically governed via a 'v-drive' system coupled to a '20/20' display controller. The planter used a double disc opener, and the planting furrow was closed using a twin-inclined press wheel. Planting depth was constantly maintained by a parallelogram that was electronically monitored via a 'delta down-force' system.

The planter software was uploaded with the trial field plan via 'SMS Ag-Leader' to generate a prescription map with +/-2 cm accuracy. Each variety was sown individually, and the planter boxes were removed and cleaned out between each variety. At Kingaroy, variety Kairi had to be replanted on 15 December 2022 due to poor establishment in the first planting.

The crop was inoculated using the group P inoculant, which was delivered by water injected into the open furrow on top of the seed before twin inclined press-wheels closed the seed drill.

All six trials were maintained in a weed-free state using pre and post-emergent herbicides Dual Gold® (S-Metolachlor) at 2L/ha; Buttress® (2,4-DB) at 1.5L/ha; Verdict® (haloxyfop) at 150mL/ha; Blazer® (Acifluoren) 2.0L/ha and Flame (Imazapic) 400 mL/ha. The trial planting and harvest dates are listed in Table 1.

**Table 1: Planting, digging and harvest dates of the trials conducted in Bundaberg and Kingaroy**

| | **Bundaberg** | | | | |
|---|---|---|---|---|---|
| Season | Plant Date | Digging Date (Runner var) | Harvest Date (Runner var) | Digging Date (Virginia) | Harvest Date (Virginia) |
| 2021/22 | 8/12/2021 | 6/05/2022 | 30/05/2022 | 21/04/2022 | 29/04/2022 |
| 2022/23 | 23/12/2022 | 8/06/2023 | 16/06/2023 | 22/05/2023 | 31/05/2023 |
| 2023/24 | 12/12/2023 | 17/05/2024 | 28/05/2024 | 17/05/2024 | 28/05/2024 |
| | **Kingaroy** | | | | |
| Season | Plant Date | Digging Date (Runner var) | Harvest Date (Runner var) | Digging Date (Virginia) | Harvest Date (Virginia) |
| 2021/22 | 14/12/2021 | 3/06/2022 | 10/06/2022 | 3/06/2022 | 10/06/2022 |
| 2022/23 | 5/12/2022 | 24/05/2023 | 2/06/2023 | 9/05/2023 | 18/05/2023 |
| 2023/24 | 6/12/2023 | 13/05/2024 | 24/05/2024 | 13/05/2024 | 24/05/2024 |

In attempt to maintain a crop canopy free of foliar diseases, rust and leaf spot, applications of fungicides; Amistar Xtra® (200g/L Azoxystrobin and 80g/L Cyproconazole); Bravo® (720g/L Chlorothalonil); Veritas (Azoxystrobin: 120 g/L and Tebuconazole: 255 g/L; Brumby® (480g/L Prothioconazole) and Miravis Duo® (125g/L Difenoconazole and 75g/L Pydiflumetofen) were applied at registered rates on a 10 – 21 day cycle from four weeks post emergence. The sites were irrigated with a high-pressure travelling irrigator (except for the 2023/24 Bundaberg site where a low-pressure 'centre pivot' was used), and application was scheduled via 'Yield Prophet'.

Emergence counts were taken at 44 days after sowing at Kingaroy and 23 days after sowing at Bundaberg. One meter of row (0.9$m^2$) was dug up using a garden spade and the number of tap roots were counted and recorded. On regular bi-weekly intervals, after one month of sowing, three plants from the non-data row were dug up, the number of flowers, pegs and pods were counted and recorded, plants were placed in hessian bags, dried at 60$^oC$ until a constant dry weight was attained, dry matter weighed, and weights recorded. Using the establishment counts (plants/ha), the number of flowers and dry matter production was converted to results on a per $m^2$ basis. While many variables were measured, the variables considered for this report are only yield and quality.

Disease ratings were collected in Bundaberg on 86, 100 and 121 days post-sowing to evaluate treatment effect on foliar disease levels, particularly rust. A visual rating tool was used (Figure 1) and the associated explanation is documented in Table 2.

Crop gross margins were calculated for the Bundaberg experiments using a 'Bega Peanuts' spreadsheet that considers cropping input costs. Variables yield, payment price (based on the proportion of edible kernels) and seed inputs were considered to provide a $/ha gross margin.

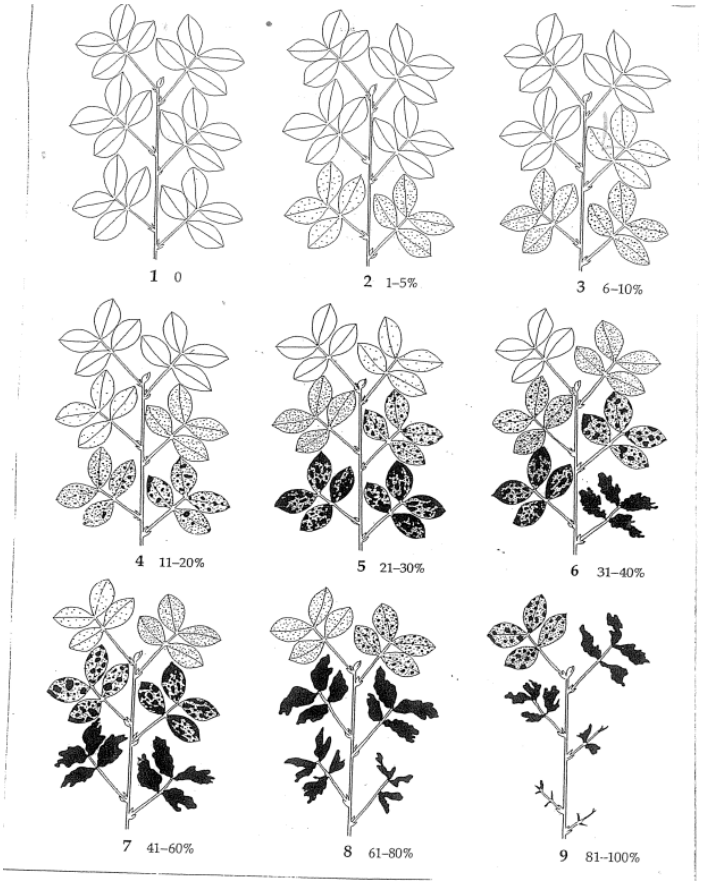


**Figure 1: Disease rating scorecard used to assess levels of foliar disease visually**

**Table 2: Disease rating score description of damage seen at the different rating levels**

| Disease score | Description | Percent leaf area damaged |
|---|---|---|
| 1 | No disease | 0 |
| 2 | Lesions on lower leaves, no defoliation | 1 – 5 |
| 3 | Lesions mostly on lower leaves, very few on middle leaves some defoliation on lower leaves | 6 – 10 |
| 4 | Lesions on lower and middle leaves with some defoliation of lower leaves | 11 – 20 |
| 5 | Lesions on all lower and middle leaves with over 50% defoliation of lower leaves | 21 – 30 |
| 6 | Severe lesions on lower and middle leaves with some lesions on top leaves. Extensive defoliation of lower leaves and some defoliation of middle leaves | 31 – 40 |
| 7 | Lesions on all leaves but less severe on top leaves. Defoliation of all lower and some middle leaves | 41 – 60 |
| 8 | Defoliation of all lower and middle leaves and some defoliation of top leaves | 61 – 80 |
| 9 | Defoliation of almost all leaves, leaving bare stems. Some leaves may be present but with severe lesions | 81 - 100 |

The yield sample at all sites consisted of 8 m of bed length/plot (14.64m$^2$). The crop was dug and inverted using a 'KMC' digger and was allowed to field dry for at least 9 days before being harvested with a KEW small plot thresher samples were placed into labelled hessian bags, then put into a 'tobacco barn' with the fan only providing aeration to dry the peanuts down to a 6.5% kernel moisture content. The 2021/22 trial at Bundaberg experienced wet weather of 219mm of rain that delayed harvest by 24 days post-digging.

The samples were then put over a 'KEW peanut cleaner' at DAF Kingaroy Research Facility to remove soil and extraneous matter. The sample was then weighed. A 1,000 g sub-sample was then hulled hand-shelled to remove peanut shell. The kernels were then placed over the 'KEW peanut grader' to determine treatment impact on grade/quality using the sieves documented in Table 3:

**Table 3: Sieve size and shape used to determine crop 'grade' for Runner and Virginia-type peanuts**

| Grade | Runner sieve size | Virginia sieve size |
|---|---|---|
| Oil – kernels that pass through | 21/64$^{th}$ round sieve | 22/64$^{th}$ round sieve |
| MFG – kernels that pass through | 22/64$^{th}$ round sieve | 24/64$^{th}$ round sieve |
| Split – kernels that pass through | 16/64$^{th}$ slotted sieve | 16/64$^{th}$ slotted sieve |
| 2's – kernels that pass through | 24/64$^{th}$ round sieve | 28/64$^{th}$ round sieve |
| 1's – kernels that pass through | 25/64$^{th}$ round sieve | 30/64$^{th}$ round sieve |
| Jumbo's – kernels that pass over | 25/64$^{th}$ round sieve | 30/64$^{th}$ round sieve |

The percent (proportion) of each grade was determined by dividing the weight of each grade (in grams) by the original 1,000g sample. Shell percentage was determined by the difference of the sum of all the grades from the original 1,000g sample.

Since 2021, the Bega Peanuts supply contract has combined the Jumbo, 1's, 2's and split's grades into one 'edible' grade. For runner varieties, growers are paid $1,775/t for edible grade kernels, $535/t for MFG grade kernels and $150/t for oil-grade kernels. The Virginia contract was $1,930/t for 'edible' grade kernels, $535/t for MFG grade kernels and $150/t for oil-grade kernels. The shell is of no economic benefit to grower payment.

For each of Bundaberg and Kingaroy, data for each year was analysed separately. Nut-inshell t/ha (NISTha) values were analysed using analysis of variance. The block structure was Rep/WholePlot/Sub/Plot and the treatment structure included the main effects of Variety and Population and their interaction. Pairwise comparisons between treatment means were investigated using Fisher's protected least significant difference (l.s.d.). As population levels increased in numerical value, a polynomial contrast of order two was also fitted to investigate curvature (quadratic) and linear trends in NISTha over the population increase. Residual plots were used to investigate normality assumptions.

For Bundaberg 2022/23 yield data, PlotID 36 (Variety=Kairi, Population=60) had a NISTha value of 3.61t/ha. This one value skewed residual plots and appeared an obvious outlier. Hence, analyses were done with and without this value to determine the impact this one value had on the results. When the value was included and an anova performed, although

ANOVA is robust to some skewness, overall P values were cross-checked using random permutation tests (based on 5000 permutations). These tests provide an alternative to using the F probabilities printed for variance ratios in an analysis-of-variance table in situations where the assumptions of the analysis are not satisfied. As omitting the PlotID36 value created an unbalanced treatment structure, this analysis was performed using restricted maximum likelihood (REML). The random model was Rep/WholePlot/Sub/Plot, and the fixed model was used to determine the main effects of Variety and Population and their interaction. Fisher's protected l.s.d. assessed pairwise comparisons between treatment means.

All analyses were performed using Genstat v24.2.

## Results and Discussion

Foliar disease - Bundaberg

In the two seasons that the experiments were conducted in the Farnsfield district, foliar disease pressure was high, with a disease rating/score of 5.9 for the 2021/22 season and a rating of 4.3 for the 2023/24 season at 121 days after planting, see Figure 2. By comparison, the 2022/23 crop was virtually unaffected by foliar diseases impacting the yield potential and kernel quality. Leaf rust has the potential to reduce pod yield by 50% or more if not treated and crops afflicted with significant late leaf spot can have yield losses up to 50% if left untreated, Middleton *et. al.* 1994.

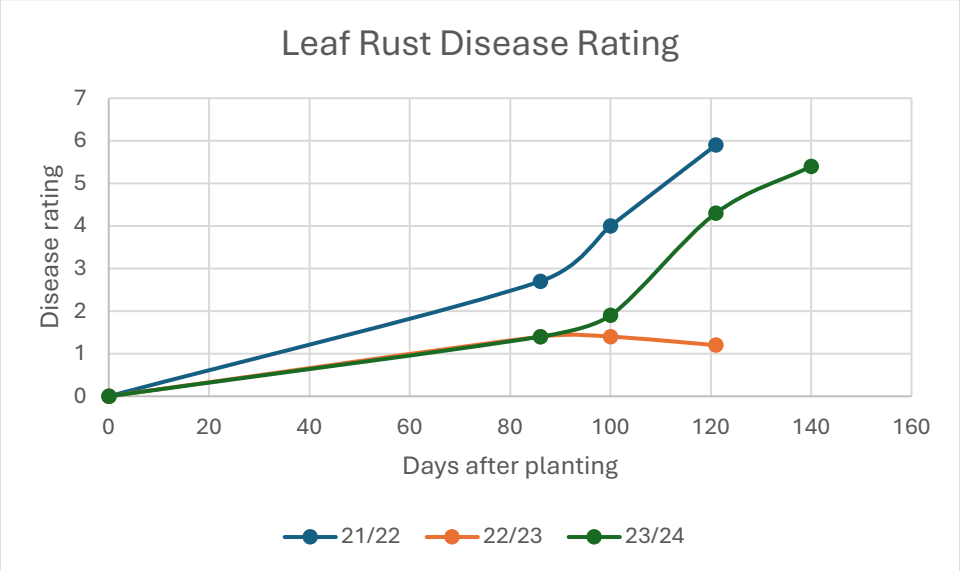


**Figure 2: The different levels of disease as rated over the three seasons that the trial was conducted in Bundaberg (averaged across the varieties)**

Bundaberg – Nut-In-Shell Yield

There was no variety by population interaction on Nut-In-Shell yields for the three seasons with P values of 0.532, 0.311 and 0.220.

There was no variety effect on Nut-In-Shell yields for the 2021/22 and 2023/24 seasons. The results from the 2021/22 Bundaberg trial were not only impacted with high disease levels (rating/score 5.9 – severe lesions on lower and middle leaves with extensive defoliation of lower leaves) and associated weakened peg strength, but also there were 24 days between digging the crop and threshing the crop. In that time, the site received 219mm of rain. The delay in threshing the crop caused considerable harvest losses, significantly impacting crop yield of the runner varieties. The Virginia variety, Wheeler, was dug and threshed earlier than the runner varieties, due to heavy leaf rust disease. This would account for the higher yield in the 2021/22 season compared to the runner varieties.

Similarly, the results from the Bundaberg 2023/24 trial were compromised with high disease pressure (rating/score of 4.3 – lesions on lower and middle leave with 11-20% of leaves with lesions and some defoliation of lower leaves) impacting on peg strength and a lack of access to irrigation resulted in a premature crop harvest.

By contrast, there was good disease control at Bundaberg during the 2022/23 season. In that season, all the runner varieties (Alloway, Holt Kairi and P85) significantly outperformed the Virginia variety Wheeler nut-in-shell yield by an average of 1.35 t/ha. The nut-in-shell yield of runner variety Kairi was 6.84 t/ha, which was 9.3% and 11.2% better than varieties Holt and P85, respectively, as can be seen in Table 4.

**Table 4: Variety effect on peanut nut-in-shell yield (t/ha) - Bundaberg**

| Variety | Year | | |
|---|---|---|---|
| | 2021/22 | 2022/23* | 2023/24 |
| Alloway | 4.35 | 6.36 [bc] | 2.45 |
| Holt | 4.99 | 6.26 [b] | 2.41 |
| Kairi | 4.43 | 6.84 [c] | 2.15 |
| P85 | 3.71 | 6.15 [b] | 2.29 |
| Wheeler | 5.10 | 5.05 [a] | - |
| Fisher | | | 2.11 |
| | | | |
| P Value | 0.155 | <0.001 | 0.599 |
| LSD (P=0.05) | - | 0.519 | - |

Nut-in-shell yield was significantly improved by 0.56 t/ha (14.4%) by increasing the plant population from 60,000 plants/ha to 120,000 plants/ha in the 2021/22 trial. Sowing at a rate to establish 240,000 plants/ha increased nut-in-shell yields to 5.03 t/ha, representing a 1.15 t/ha (29.6%) increase over the 60,000 plant/ha sowing rate.

By contrast there was no effect of plant population on nut-in-shell yield in the 2022/23 season with the 60,000 plant/ha treatment having a nut-in-shell yield of 6.17 t/ha.

As with the 2021/22 season there was a plant population effect on nut-in-shell yield for the 2023/24 crop, where the 180,000 plants/ha treatment out-performed the 60,000 plants/ha treatment by 0.39 t/ha, a 18.9% yield improvement. In contrast to the 2021/22 season, the highest yield was achieved at the 180,000 plant/ha sowing rate, as can be seen in Table 5.

It is worth noting that high foliar disease levels compromised both the 2021/22 and the 2023/24 seasons; whereas the 2022/23 season where foliar diseases were well controlled planting population offered nothing in terms of nut-in-shell yield responses.

**Table 5: Population effect on peanut nut-in-shell yield (t/ha) - Bundaberg**

| Population (plants/ha) | Year | | |
|---|---|---|---|
| | 2021/22 | 2022/23 | 2023/24 |
| 60,000 | 3.88 [a] | 6.17 | 2.06 [a] |
| 120,000 | 4.44 [b] | 6.13 | 2.19 [a] |
| 180,000 | 4.71 [b] | 6.10 | 2.45 [b] |
| 240,000 | 5.03 [c] | 6.15 | 2.43 [b] |
| | | | |
| P Value | <0.001 | 0.976 | <0.001 |
| LSD (P=0.05) | 0.28 | - | 0.18 |

Kernel Quality – Proportion of edible kernels (Bundaberg)

There was no variety by population interaction in both the 2022/23 and 2023/24 seasons, with P values of 0.849 and 0.831, respectively. However, there was a statistically significant (P=0.011) variety by population interaction on the proportion of edible-grade peanut kernels in the 2021/22 season

In the 2021/22 season, altering the planting population from 60,000 to 240,000 plants/ha did not affect the proportion of edible grade kernels for the runner variety Alloway and the Virginia variety Wheeler. By contrast, increasing the plant population from 60,000 plants/ha to 180,000 plants/ha significantly increased the proportion of edible grade kernels from 57.2% to 70% for the runner variety Holt. Increasing the population past 180,000 plants/ha did not improve the proportion of edible kernels for variety Holt.

The runner variety Kairi demonstrated the highest proportion of edible grade kernels, 55.8% of the 240,000 plants/ha population, compared to 38.4% of the lowest population. The proportion of edible kernels for runner variety P85 increased from 44.9% for the 60,000 plants/ha population to 59.7% for the 120,000 plants/ha population; increasing the plant population past 120,000 plants/ offered no improvement in the proportion of edible grade peanut kernels (Figure 3).

Whilst the 2021/22 season interaction is interesting, this site was firstly compromised with the highest foliar disease rating of the three seasons and secondly by the 24-day delay between digging and inverting the crop and plot harvest along with some 219mm of rainfall.

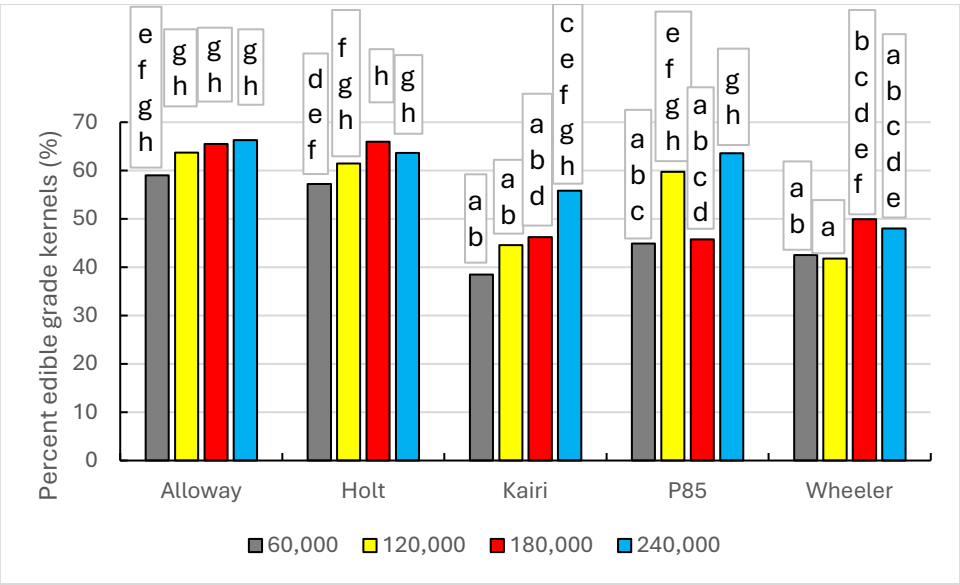


**Figure 3: Variety by plant population interaction on the proportion of edible grade peanut kernels in the 2021/22 season at the Bundaberg site. Treatments with the same letter are NOT significantly different (P=0.05).**

Runner variety Alloway realised the highest proportion of edible grade kernels in the 2022/23 trial at 71% of nut-in-shell yield, and variety Kairi the lowest edible grade kernels of the runner varieties at 64%. However, all the runner varieties produced more edible grade kernels than the Virginia variety Wheeler. The proportions of edible grade kernels were ranked Alloway > Holt ≥ P85 > Kairi > Wheeler.

The impact of high foliar disease levels and premature harvesting of the 2023/24 trial at Bundaberg is evident, with a trial grand mean of 33.4% edible kernels compared to the previous season's 65.8%. Notwithstanding the constraints of the trial runner variety, Alloway, provided the highest proportion of edible grade kernels with a back-transformed mean of 45%. For the 2023/24 season, the ranking of edible grade kernels by variety was Alloway > Holt ≥ Fisher ≥ P85 ≥ Kairi (Table 6).

**Table 6: Variety effect on the proportion of edible grade peanut kernels - Bundaberg**

| Variety | 2022/23 | 2023/24 | |
|---|---|---|---|
| | | Logit transformed | Back transformed |
| Alloway | 0.71 [d] | -0.189 [d] | 0.45 |
| Holt | 0.68 [c] | -0.479 [c] | 0.38 |
| Kairi | 0.64 [b] | -1.189 [a] | 0.23 |
| P85 | 0.66 [c] | -0.962 [ab] | 0.28 |
| Wheeler | 0.60 [a] | | |
| Fisher | | -0.691 [bc] | 0.33 |
| | | | |
| P Value | <0.001 | <0.001 | |
| LSD | 0.02 | 0.287 | |

In both the 2022/23 and 2023/24 seasons, the treatment of the 60,000 plants/ha plant population resulted in the lowest proportion of edible grade peanut kernels. In the 2022/23 trial, where foliar diseases were well managed, increasing the plant population to 120,000 plants/ha significantly increased the proportion of edible grade kernels to 66% of nut-in-shell yield; with increasing the plant population in excess of 120,000 plants/ha offering no improvement in the proportion of edible grade kernels.

By contrast, in the 2023/24 season, there was a gradual improvement in the proportion of edible grade kernels through the range of plant populations with back-transformed means of 30%, 32%, 34% and 37% for the 60,000,120,000, 180,000, and 240,000 plants/ha populations respectively, see Table 7. This crop was disease-affected and harvested prematurely, potentially influencing this result.

**Table 7: Population effect on the proportion of edible grade kernels - Bundaberg**

| Population (plant/ha) | 2022/23 | 2023/24 | |
|---|---|---|---|
| | | Logit transformed | Back transformed |
| 60,000 | 0.63 [a] | -0.845 [a] | 0.30 |
| 120,000 | 0.66 [b] | -0.759 [ab] | 0.32 |
| 180,000 | 0.67 [b] | -0.660 [bc] | 0.34 |
| 240,000 | 0.67 [b] | -0.543 [c] | 0.37 |
| | | | |
| P Value | <0.001 | <0.001 | |
| LSD | 0.013 | 0.132 | |

The improvement in proportion of edible grade kernels with increased population is primarily because a higher plant population causes the plants to grow more erect, unlike the prostrate growth observed at lower densities. When the density is high, this upright growth makes it difficult for the pegs to reach the soil at higher nodes, allowing existing pegs to form complete pods. However, this advantage comes at the cost of needing a higher seed rate.

Crop Gross Margin - Bundaberg

There was no variety by population interaction on gross margin with P values of 0.259, 0.819 and 0.171 for the 2021/22, 2022/23 and 2023/24 seasons, respectively.

There was a vast difference in the profitability of peanut production in the Bundaberg environment between the different years that the trials were conducted. For example, the trial grand mean gross margin for the 2021/22 crop was $685/ha. The 2022/23 crop was highly profitable, with a trial grand mean gross margin of $3,014. However, the poor yield and the low proportion of edible grade kernels for the 2023/24 crop resulted in a grand mean gross margin of -$1,862/ha.

Despite the significant difference in gross margin between the varieties, ranging from a loss of -$50/ha for Kairi and $1,639 for Holt in the 2021/22 season, these differences were not statistically significant (P=0.117).

The average gross margin for the runner varieties (Alloway, Holt, Kairi and P85) was $3,319/ha, a value some $1,522/ha (84.7% more) greater than was achieved for the Virginia variety Wheeler in the 2022/23 season. There was no difference in the profitability of the runner varieties that year.

Alloway lost the least money for the 2023/24 season trial (-$1,400/ha), whereas variety Kairi was the least profitable at -$2,407/ha. The range was Alloway $^{c}$ ≥ Holt $^{bc}$ ≥ Fisher $^{b}$ ≥ P85 $^{ab}$ ≥ Kairi $^{a}$; see Table 8.

**Table 8: Effect of variety on peanut gross margin ($/ha)**

| Variety | Year | | |
|---|---|---|---|
| | 2021/22 | 2022/23* | 2023/24 |
| Alloway | 1,004 | 3,573 $^{b}$ | -1,400 $^{c}$ |
| Holt | 1,639 | 3,334 $^{b}$ | -1,608 $^{bc}$ |
| Kairi | -50 | 3,313 $^{b}$ | -2,407 $^{a}$ |
| P85 | 26 | 3,055 $^{b}$ | -2,018 $^{ab}$ |
| Wheeler | 805 | 1,797 $^{a}$ | - |
| Fisher | - | - | -1,876 $^{b}$ |
| | | | |
| P Value | 0.117 | <0.001 | 0.008 |
| LSD (P=0.05) | - | 543 | 462 |

The only season where plant population had a statistical effect on crop gross margin was the 2021/22 season, where, despite the extra seed input cost, the 240,000 plants/ha treatment had the highest gross margin of $1,206/ha. The gross margin of the 240,000 plants/ha treatment was $556/ha and $1,157/ha better than the 120,000 and 60,000 plants/ha treatments, respectively, see Table 9.

Despite the significant improvement in the proportion of edible grade kernels attained through increasing plant population from 60,000 to 120,000 plants/ha in the 20223/23 season, that increase only resulted in a non-statistically significant difference of $123/ha.

Similarly, the improvement in the proportion of edible grade kernel attained through increased plant populations in the 2023/24 season, this impact did not flow through to improved profitability.

**Table 9: The effect of plant population on peanut gross margin ($/ha)**

| Population (plants/ha) | Year | | |
|---|---|---|---|
| | 2021/22 | 2022/23 | 2023/24 |
| 60,000 | 49 [a] | 3,003 | -1,847 |
| 120,000 | 650 [b] | 3,126 | -1,868 |
| 180,000 | 833 [bc] | 3,035 | -1,827 |
| 240,000 | 1,206 [c] | 2,894 | -1,905 |
| | | | |
| P Value | <0.001 | 0.339 | 0.807 |
| LSD (P=0.05) | 423 | - | - |

Kingaroy – Nut-In-Shell Yield

There was no variety by population interactions with P values of 0.831; 0.914 and 0.419 for the 2021/22; 2022/23 and 2023/24 seasons, respectively.

There were no significant variety effects on nut-in-shell yield for the 2022/23 and the 2023/24 seasons.

In the 2021/22 season, runner variety Alloway out-performed runner variety Holt and Virginia variety Wheeler by 1.57t/ha and 3.86t/ha, respectively. All the runner varieties (Alloway, Holt, Kairi and P85) out-performed Virginia variety Wheeler (Table 10)

Nut-in-shell yield was more stable through time (2021-24) in Kingaroy than in Bundaberg. This stability is potentially due to two factors: i) the inland environment traditionally has lower disease pressure and ii) the same farm and grower (Kingaroy Research Facility) was used in all three seasons whereas in Bundaberg three different sites and two different growers were assisting with crop husbandry.

**Table 10: Variety effect on peanut nut-in-shell yield (t/ha) - Kingaroy**

| Variety | 2021/22 | 2022/23 | 2023/24 |
|---|---|---|---|
| Alloway | 5.01 [c] | 5.08 | 6.85 |
| Holt | 3.44 [b] | | 7.01 |
| Kairi | 3.98 [bc] | 5.26 | 6.64 |
| P85 | 4.71 [c] | 5.14 | 6.46 |
| Wheeler | 1.15 [a] | 5.66 | |
| Fisher | | | 6.33 |
| | | | |
| P Value | <0.001 | 0.586 | 0.179 |
| LSD | 1.14 | - | - |
| | | | |

The plant population did not affect peanut nut-in-shell yield in any season in the Kingaroy trials, see Table 11.

**Table 11: Plant population effect on peanut nut-in-shell yield (t/ha)**

| Population (plant/ha) | 2021/22 | 2022/23 | 2022/23 Holt only | 2023/24 |
|---|---|---|---|---|
| 60,000 | 3.70 | 5.10 | 5.73 | 6.33 |
| 120,000 | 3.62 | 5.34 | 5.24 | 6.82 |
| 180,000 | 3.51 | 5.28 | 4.43 | 6.79 |
| 240,000 | 3.79 | 5.42 | 5.74 | 6.68 |
| | | | | |
| P Value | 0.598 | 0.522 | 0.102 | 0.083 |
| LSD | - | - | - | - |

Kernel Quality – Proportion of edible kernels (Kingaroy)

Runner variety P85 had the highest proportion of edible grade peanut kernels in the 2021/22 season with 64% of nut-in-shell yield being edible kernels. Varieties Alloway and Kairi had statistically similar proportions of edible-grade kernels to that of P85. However, P85 had a significantly higher proportion of edible grade kernels than runner variety Holt and Virginia variety Wheeler. Runner varieties Alloway, Kairi and P85 had significantly more proportions of edible grade kernels than the Virginia variety Wheeler, see Table 12.

Runner varieties Alloway, Kairi and P85 had statistically higher proportions of edible grade kernels than Virginia variety Wheeler in the 2022/23 season. However, there were no differences in the proportions of edible-grade kernels between the runner varieties.

There were no variety effects on the proportion of kernels that were classified as an edible grade in the 2023/24 season.

**Table 12: Variety effect on proportion of edible grade kernels - Kingaroy**

| Variety | 2021/22 | 2022/23 | 2023/24 |
|---|---|---|---|
| Alloway | 0.61 $^{bc}$ | 0.71 $^{b}$ | 0.59 |
| Holt | 0.58 $^{ab}$ | | 0.58 |
| Kairi | 0.62 $^{bc}$ | 0.67 $^{b}$ | 0.57 |
| P85 | 0.64 $^{c}$ | 0.70 $^{b}$ | 0.63 |
| Wheeler | 0.54 $^{a}$ | 0.60 $^{a}$ | |
| Fisher | | | 0.56 |
| | | | |
| P Value | 0.014 | 0.002 | 0.079 |
| LSD | 0.053 | 0.0397 | - |

Plant population did not affect the proportion of edible grade kernels in the 2021/22 and the 2023/24 growing seasons.

Due to the error at planting of the 2022/23 crop variety, Holt had to be analysed separately. Altering planting populations from 60,000 to 240,000 plants/ha did not influence the proportion of edible grade kernels for variety Holt. However, in the 2022/23 season, there was a statistically significant improvement in the proportion of edible grade kernels between the 60,000 and 240,000 plants/ha treatments, where the increased population improved the proportion of edible grade kernels.

**Table 13: Population effect on proportion of edible grade kernels - Kingaroy**

| Population (plant/ha) | 2021/22 | 2022/23 | 2022/23 Holt only | 2023/24 |
|---|---|---|---|---|
| 60,000 | 0.61 | 0.66 [a] | 0.84 | 0.59 |
| 120,000 | 0.60 | 0.67 [ab] | 0.72 | 0.58 |
| 180,000 | 0.60 | 0.67 [ab] | 0.76 | 0.58 |
| 240,000 | 0.58 | 0.68 [b] | 0.72 | 0.59 |
| | | | | |
| P Value | 0.298 | 0.033 | 0.278 | 0.729 |
| LSD | - | 0.016 | - | - |

## Conclusion

Bundaberg

The annual variation in the profitability of peanut production represents a threat to the sustained production of peanuts in the Coastal environment. Attention to detail on a foliar disease management program, correct harvest date and weather events drove the variability in yield and proportion of edible grade kernels in these experiments.

Variety impact on nut-in-shell yield occurred in only the 2022/23 season where all the runner varieties out-performed the Virginia type and variety Kairi and Alloway performing well of the runner types. The plant population only affected nut-in-shell yield in the seasons when there were high levels of foliar disease. In 2021/22 yield was maximised at 240,000 plants/ha whereas yield was maximised at 180,000 plants/ha in 2023/24. In the season where foliar diseases were well managed, yield was stable across the range tested (60,000 – 240,000 plants/ha).

There was an interesting interaction between variety and plant population in 2021/22 season, where the quality of varieties Alloway and Wheeler were unaffected by population. The quality of the variety of Kairi has improved with the increasing population. The quality of Holt and P85 was maximised at populations of 180,000 and 120,000 plants/ha respectively. However, it must be remembered that not only was the site affected by foliar disease, but there was also a significant period of 24 days between digging and harvesting. In that trial, 219mm of rainfall occurred.

When foliar disease was controlled in 2022/23, quality was maximised at 120,000 plant/ha and when the disease affected the 2023/24 crop quality was maximised at 240,000 plant/ha.

Based on these trials growers in coastal environments should target a population of 180,000 plants/ha as a strategy to minimise the impact of possible disease incursions. Current commercial varieties Alloway and Holt have the most consistent reliability in quality over the three years.

Kingaroy

In 2021/22 all runner varieties out-performed the Virginia variety, and variety Alloway out-performed variety Holt in terms of nut-in-shell yield. In the other seasons variety did not have a significant effect on nut-in-shell yield. Manipulating populations in the range tested in these experiments (60,000 – 240,000 plants/ha) did not affect nut-in-shell yield in any season.

Variety Wheeler had a lower proportion of edible grade kernels than the runner type varieties. In two of the three seasons (2021/22 and 2023/24) plant population had no effect on the proportion of edible grade kernels. In the 2022/23 season, the 240,000 plant/ha treatment had a greater proportion of edible grade kernels than the 60,000 plant/ha treatment, but it was not different from the 120,000 and 180,000 plants/ha treatments.

Based on these results, irrigated growers in the inland Burnett should aim to establish 120,000 plants/ha to maximise their production of edible-grade peanut kernels.

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